WEARABLE SENSORS BASED GAIT ACQUISITION FOR MOTION ANALYSIS AND PROSTHETIC ANKLE-FOOT DESIGN

Thesis submitted in partial fulfilment

for the Award of Degree

Doctor of Philosophy

by

SACHIN NEGI

SCHOOL OF BIOMEDICAL ENGINEERING

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(BANARAS HINDU UNIVERSITY)

VARANASI – 221005

18021008 *January 2022*

APPENDIX A

GUI for Gait Analysis

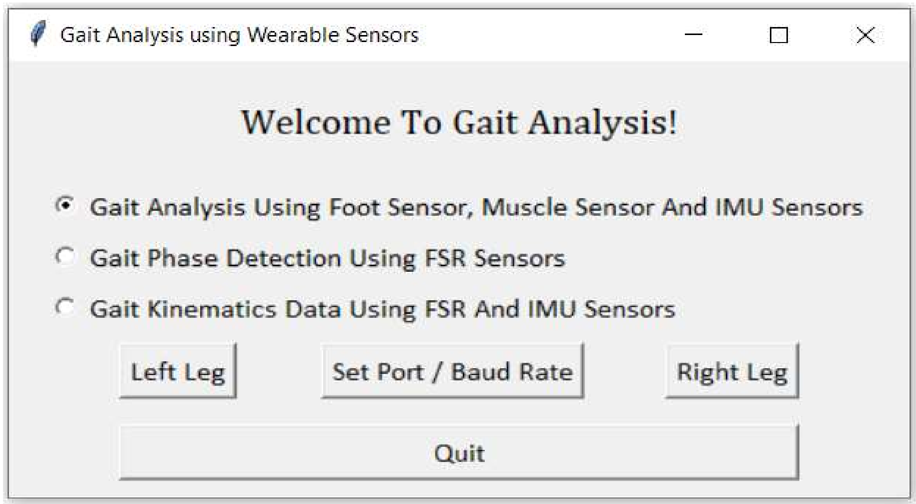

Figure A.1 *Graphical user interface (GUI) for gait analysis using FSR, IMU, and EMG sensors*

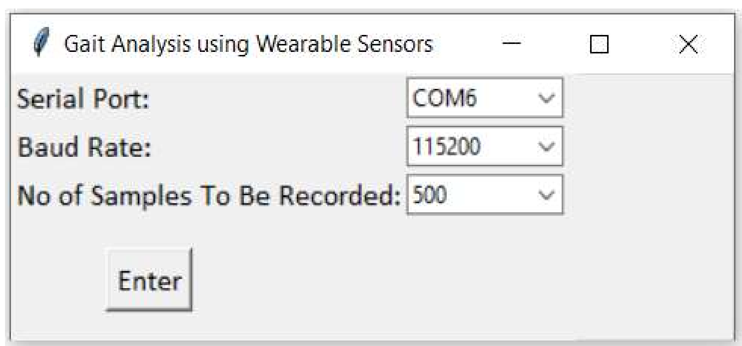

Figure A.2 *GUI options for the selection of serial port, baud rate and number of samples to record*

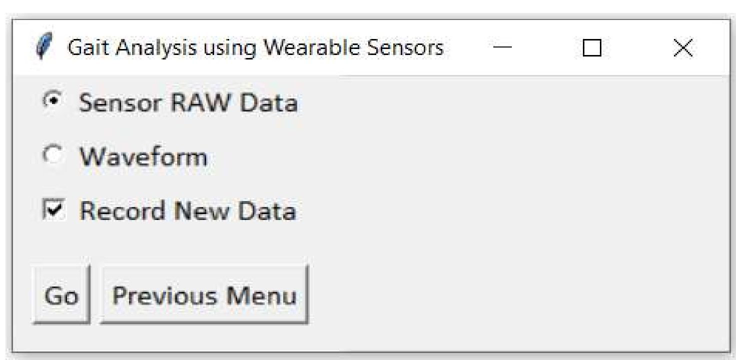

Figure A.3 *GUI options to record new raw sensor data, and display the recorded waveform*

APPENDIX B

Printed Circuit Boards

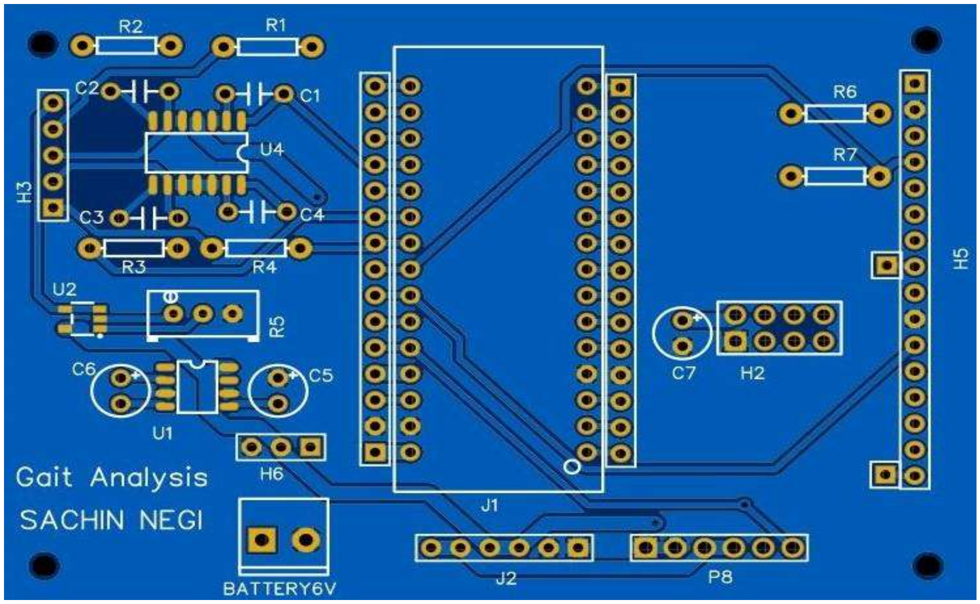

Figure B.1 *Printed circuit board 2-D view for gait analysis using FSR, IMU, and EMG sensors*

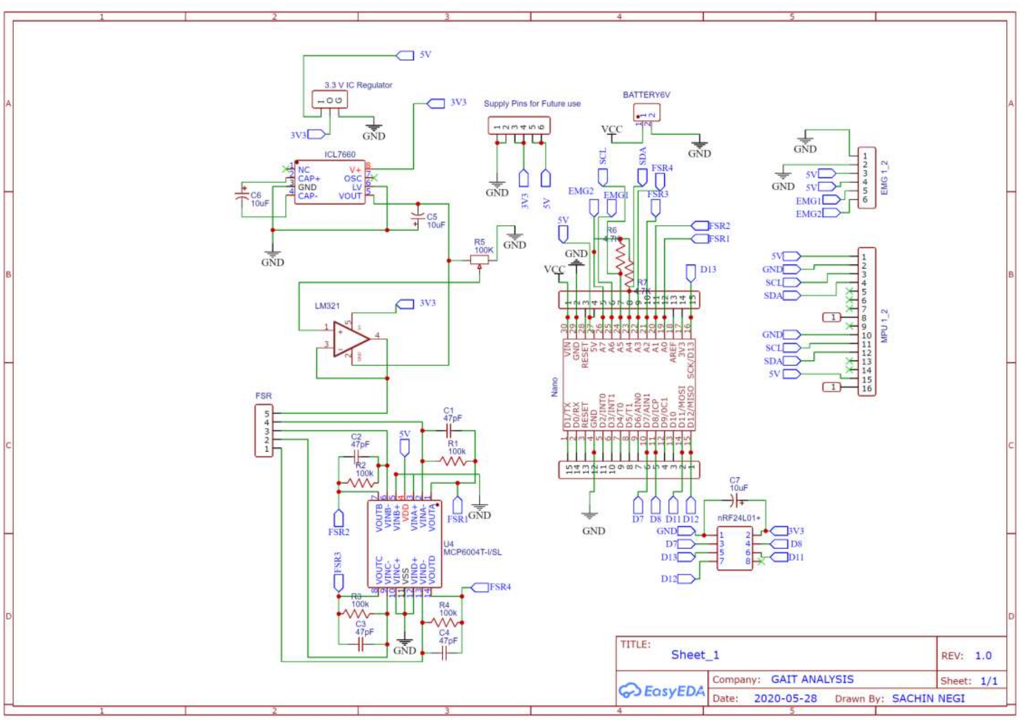

Figure B.2 *Schematic diagram of the circuit for gait analysis using FSR, IMU, and EMG sensors*

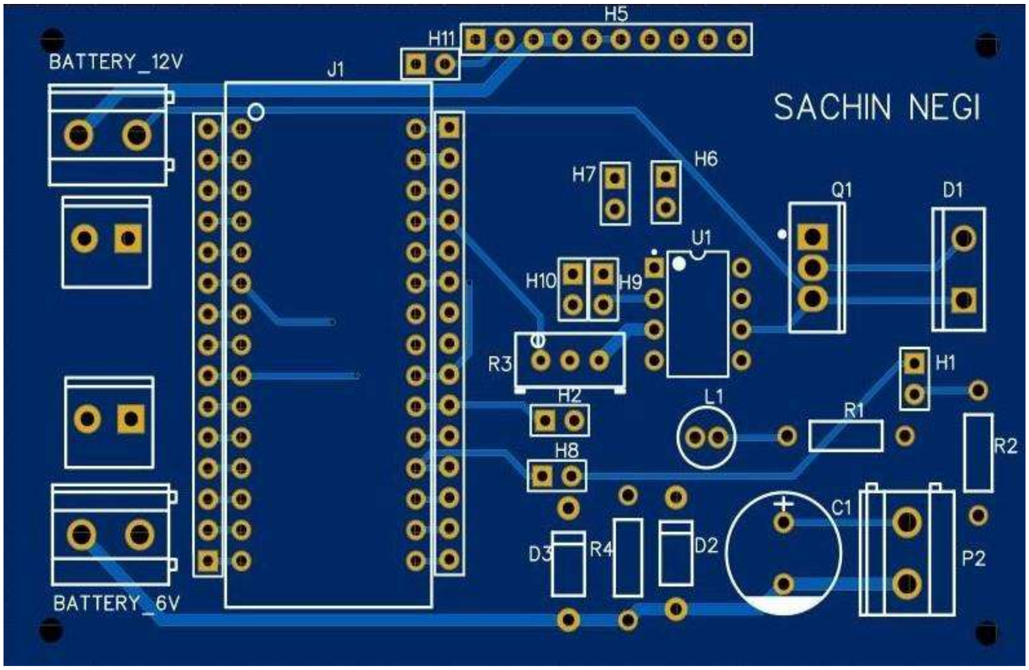

Figure B.3 *Printed circuit board 2-D view for Arduino Nano-based MR damper control*

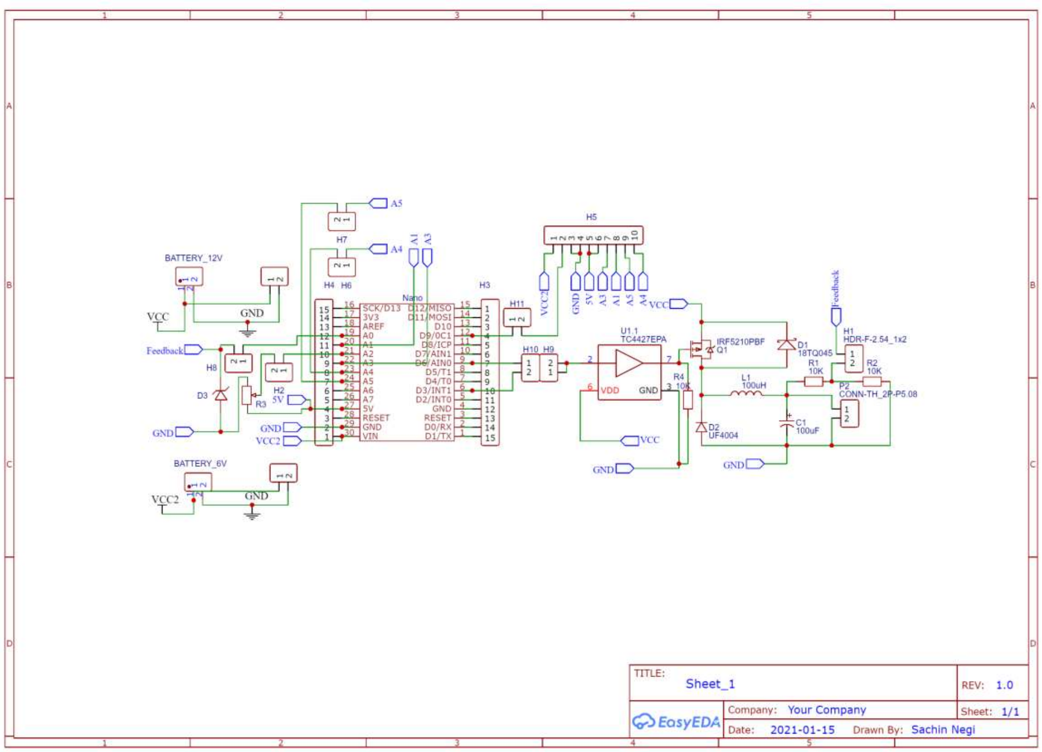

Figure B.4 *Schematic diagram for Arduino Nano-based MR damper control circuit*

APPENDIX C

Ethical Clearance Certificate

INSTITUTE OF MEDICAL SCIENCES

BANARAS HINDU UNIVERSITY

ECR/Bhu/Inst/UP/2014/Re-registration-2017 dt. 31.01.2017

No. Dean/2019/EC/ 1333

Dated: 07.05.2019

The Coordinator
School of Biomedical Engineering
Indian Institute of Technology
Banaras Hindu University

Dear Sir,

The Ethical Committee meeting was held on 07.05.2019at 3.00 PM in the Chamber of the Dean, Faculty of Medicine, IMS to review the progress of the project 2016-17 as per the details given below::

Name of the Student	Sachin Negi
Synopsis Title	Study/Development of Ankle foot Prostheses/Orthoses for Hilly region
Suggestions	The Head of Department of Radiodiagnosis should be consulted for the project and suggestion may be obtained.
Remarks	**The Study is approved by the Institute Ethical Committee**

This is for your information and necessary action at your end.

(DR. KIRAN GIRI)
MEMBER SECRETARY

Yours sincerely,

(PROF. V. BHATTACHARYA)
CHAIRPERSON OF THE ETHICAL COMMITTEE

APPENDIX D

Consent Statement of Amputee

NAUTIYAL ORTHOTIC-PROSTHETIC REHABILITATION CLINIC

NORA DEHRADUN

BIO-Er. V.K. Nautiyal
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Ref. No. —

Dated 8/1/2021

Consent Statement

I, Surjan Singh, age 32 years, height 168 cm, and weight 70 Kg, want to state that I have transtibial amputation for the last 11 years in an accident. And I have no objection to giving my trial to the Prosthetic leg model designed by Mr. Sachin Negi under the supervision of my prosthetist Dr. V. K. Nautiyal.

सुरजनसिंह

SURJAN SINGH

Verified

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LIST OF PUBLICATION

A) Journal Publications

1. Negi, S. and Sharma, N. (2022), "A standalone computing system to classify human foot movements using machine learning techniques for ankle-foot prosthesis control", ***Computer Methods in Biomechanics and Biomedical Engineering***, *25*(12), pp.1370-1380. **[SCIE]**

2. Negi, S., Sagar, U., Nautiyal, V.K. and Sharma, N. (2022), "Design and analysis of magnetorheological damper based ankle-foot prosthesis prototype", ***Industrial Robot***, Vol. 49 No. 2, pp. 240-248. **[SCIE]**

3. Negi, S., Sharma, S. and Sharma, N. (2021), "FSR and IMU sensors-based human gait phase detection and its correlation with EMG signal for different terrain walk", ***Sensor Review***, Vol. 41 No. 3, pp. 235-245. **[SCIE]**

4. Negi, S., Negi, P.C., Sharma, S. and Sharma, N. (2020), "Human locomotion classification for different terrains using machine learning techniques", ***Critical Reviews™ in Biomedical Engineering***, *48*(4). **[Scopus]**

5. Negi, S., CBS Negi, P., Sharma, S., and Sharma, N. (2020), "Electromyographic and acceleration signals-based gait phase analysis for multiple terrain classification using deep learning", ***International Journal of Advanced Research in Engineering and Technology***, *11*(6).

B) Conference/ Workshop

1. Negi, S., Garg, K., Prajapat, M., & Sharma, N. (2022), "A Standalone Real-Time Gait Phase Detection Using Fuzzy-Logic Implementation in Arduino Nano", ***SN Computer Science***, *3*(1), 1-7. **[Scopus]**

2. Negi, S., Negi, P. C., Singh, D. B. V., & Sharma, N. (2021), "Comparative Analysis of SVM and DNN for Multiple Terrain Classification Using Hybrid Sensor", In ***Proceedings of Integrated Intelligence Enable Networks and Computing*** (pp. 317-325). Springer, Singapore.

3. Sachin Negi, Shahrukh Khan, and Neeraj Sharma, An Energy-Efficient Insole: A Wearable Device for Gait Monitoring in Daily Life. *2019 World Conference on Access to Medical Products- achieving the SDGs 2030, 19-21 November 2019, Taj Hotel, New Delhi, India* [**WHO- Poster presentation**].